Mobile phone use while driving: a Structural Equation Model to analyze the Behavior behind the wheel

Telefono cellulare alla guida: un Modello a Equazioni Stutturali per analizzare il comportanto al volante

Carlo Cavicchia and Pasquale Sarnacchiaro

Abstract The use of mobile phones while driving is one of the main causes of road accidents and it is an ever-growing phenomenon. The key aim of this study is to simultaneously analyze individual Knowledge, Attitudes, and Behaviors toward the use of mobile phones while driving in one of the largest and most populous metropolitan areas of Italy, Naples. The data acquired from 774 questionnaires - administered to subjects evenly divided by gender and with an average age of 39 years - revealed that 69% of the participants had used their mobile phone while driving at least once in their lifetime. A Structural Equation Model shows how the relationship between Knowledge and Behavior passes through the Attitude. According to the collected data and statistical analysis, it is possible to identify factors that can greatly affect the use of mobile phone while driving.

Abstract *L'uso del telefono cellulare alla guida è un fenomeno in forte crescita e rappresenta una della maggiori cause di incidenti stradali. Lo scopo della ricerca è l'analisi simultanea delle conoscenze (Knowledge), delle attitudini (Attitudes) e dei comportamenti (Behaviors) riguardanti l'uso dei telefoni cellulari alla guida, prendendo in esame Napoli, una delle aree metropolitane più grandi e popolosa d'Italia. I dati raccolti da* 774 *questionari - somministrati a patentati, sia uomini che donne, con un'età media di* 39 *anni - rivelano che il* 69% *dei partecipanti ha usato il telefono cellulare alla guida almeno una volta nel corso della propria vita. Un modello a Equazioni Strutturali mostra come la relazione tra comportamenti e conoscenze sia veicolata dalle attitudini. Questo studio, attraverso i dati raccolti e le analisi svolte, permette di identificare i fattori che maggiormente influenzano l'uso del cellulare alla guida.*

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1 Introduction

Every year around 1.35 million people pass away because of road traffic crashes, while between 20 and 50 million more people suffer non-fatal injuries [2]. There are several factors that increase both the road traffic crashes risk and their resulting risk of injury or death worldwide. Speeding and driving under the influence of alcohol or other psychoactive substances are two of the most important determinants of road accidents and they present significant risk factors for road traffic injuries. However, other risk factors can be identified: non-use of safety devices such as motorcycle helmets, seat-belts, and child restraints, or distraction while driving, including the use of mobile phones [3]. Distracted driving is therefore considered as a major cause of these remarkable numbers. Specifically, the WHO Global Status Report on Road Safety 2018 [2] underlines that people which use mobile phones while driving are approximately 4 times more likely to be involved in a crash than drivers not using a mobile phone. In detail, the use of mobile phones while driving slows reaction times, and makes it difficult to keep in the correct lane, or to keep the correct following distances [2]. In Italy, this tendency seems confirmed; indeed, distraction is presumed to be the primary cause (16.3%) of road crashes, against speeding (10.2%), alcohol-related DUI (3.9%) and drug-related DUI (3.2%) [1], and one of the most important causes of distraction while driving appears to be the use of a mobile phone [6].

In this paper, we analyze the Behaviors enacted by Italian drivers regarding mobile phone use while driving, as well as the level of mobile phone involvement and its frequency of use. The key aim of this study is to simultaneously analyze through a Structural Equation Model (SEM) Knowledge, Attitudes, and Behaviors towards the use of mobile phones while driving in one of the largest and most populous metropolitan areas of Italy, Naples. Analysis of Knowledge, Attitudes and Behaviors about the risks of mobile phone usage while driving can lead us to identify its determinants in order to obtain the means to sensitize public opinion and improve people's awareness regarding the correct Behavior to adopt while driving.

This paper is structured in three sections: the next section deals with a brief description of methods used in the study. In the third section, the results of the SEM are pointed out. A brief conclusion ends the paper.

2 Research Methodology

The SEM is a statistical method for testing and estimating at once causal relationships among multiple independent and dependent latent (LVs) and manifest variables (MVs). SEM entails different sub-models. The structural model comprises the rela-

tionships among the LVs which have to be developed from theoretical considerations. The independent LVs are also referred to as exogenous LVs and the dependent LVs as endogenous LVs. For each of the LVs within the SEM a measurement model has to be defined. These models embody the relationships between the MVs and the LVs, and they can be either reflective or formative. In SEM related literature, two different types of techniques are established: covariance-based ones, as represented by LInear Structural RELations (LISREL,[4]), and variance-based ones, of which the Partial Least Squares (PLS) path modelling [7] is the most prominent representative.

In this paper we used the PLS, performed by SmartPLS (Version 3), because of its less stringent distributional assumptions for the variables and error terms and its ability to work with both reflective and formative measurement models. PLS-SEM is widely used for group comparison, investigating the possible presence of a group-effect in the definition of the LVs. The analysis of the invariance of the measures across different groups is necessary when using PLS-SEM for group comparison. SmartPLS provides permutation-based confidence intervals that allow determining if the correlation between the composite scores of the two groups is significantly lower than one (null hypothesis, H_0: $c = 1$). If the null hypothesis is not rejected, the composite does not differ much in both groups and, therefore, there is compositional invariance. In the next step, permutation-based confidence intervals for the mean values and the variances allow assessing if the composites' mean values and variances differ across groups.

3 Results

3.1 Sample and data characteristics

We analyzed 774 anonymous self-report surveys in the entirety of the metropolitan city of Naples. The questionnaire was anonymous and consisted of demographic information about the participant and three pools of queries focusing on Knowledge, Attitudes and Behaviors concerning the habit and frequency of mobile phone use while driving, for a total of 46 questions. Knowledge and Attitudes were assessed on a three-point Likert scale with options for "agree", "neither agree nor disagree", and "disagree", while inquiries regarding Behavior were presented in a four-answer format of "never", "sometimes", "often", and "always". Important general characteristics of the study sample can be reported: the mean age of the study sample is 39.27 years and most of participants are high school graduates or have a post graduate degree. 89% of the sample had been driving for more than 5 years and 54% of the sample drove a car; only the 27.6% of the interviewed drove both a car and a motorcycle. More than 75% of the sample was aware about the risks about using mobile phone while driving, but 28% of them was unaware that this practice was forbidden by law. Most of the participants thought that mobile phone usage was essential and more than 50% thought that it was necessary for business. Moreover, 24% of the sample admitted

to reading text messages, while only 16% admitted to writing them. Respondents had mainly sought general information about the risks concerning mobile phone use while driving, but only 30% kept themselves up to date on laws that regulated its use while driving. For the purpose of the study, PLS multigroup analyses based on the participants' socio-demographic profile (e.g., gender, age, education level, type of vehicle driven, level of driving experience) were performed.

3.2 Structural Equation Model

PLS-SEM was performed to formalize a scheme for the interpretation of driving Behavior and to detect its drivers. Starting from the considerations elaborated in the previous sections, we hypothesized that Knowledge and Attitude were exogenous LVs, while Behavior was an endogenous LV. Following the criteria summarized in [5], we supposed that Knowledge and Attitude were formative LVs and Behavior was reflective LV. The PLS estimations showed that the relationships between Behavior and Attitude and Attitude and Knowledge were statistically significant (1).

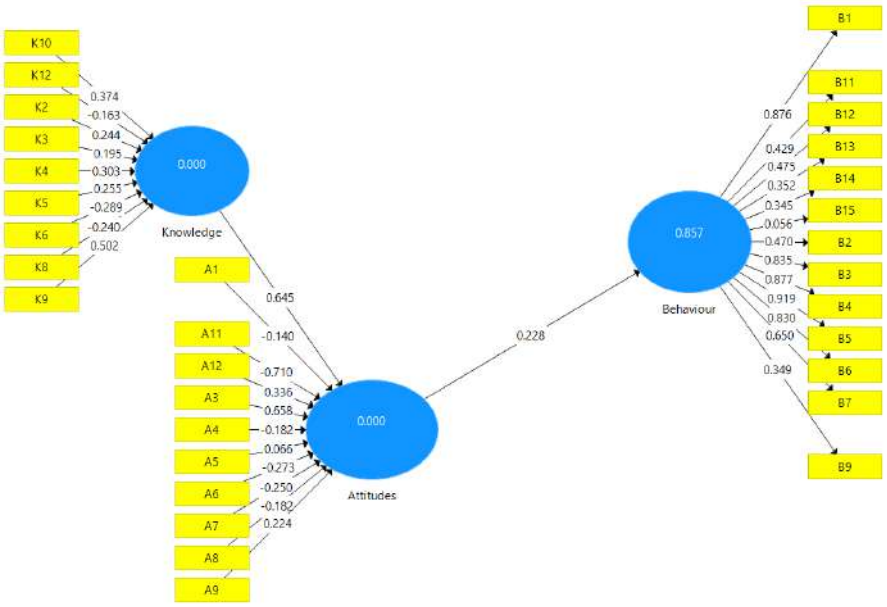

Fig. 1: Structural Equation Model – Path analysis

The goodness of the model was ultimately very strong ($R^2 = 0.856$). With regards to the path coefficients, we observed that the impact of the Knowledge on the Attitude

was considerably greater (0.645) than the impact of the Attitude on the Behavior (0.228). Also the indirect impact of the Knowledge on the Behavior resulted being important (0.147). It is noteworthy that these three impacts and all the outer loadings for latent variables were statistically significant. The direct effect of Knowledge on Behavior was tested but this effect eventually resulted not statistically significant.

4 Conclusions

The results of the present research supported the conclusion that the model well represented the collected data according to the result of the goodness-of-fit test. Similarly to earlier studies, this paper confirmed the goodness of the general structural model in helping to understand and explain how Knowledge, Attitude and Behavior are related. The analyzed population showed a good Knowledge on the subject together with positive Attitudes, and there was a general agreement that using a mobile phone while driving is considered unacceptable, even though the employed Behaviors are knowingly inappropriate according to Italian laws. Through our research we discovered that the relatively elevated education level of the sample and the greater driving experience (measured in years of driving license) of the participants were proven as inversely associated with the Behaviors examined; this means that while the experimental results of this survey can be used for the creation of targeted educational programs, community-based interventions and legal regulations, it might be fundamental to act more firmly in order to directly improve people's overall Behavior while driving. All these measures alone, in fact, may not be sufficient to reduce a phenomenon that is so deeply rooted in the population. This ever-growing phenomenon closely follows the technological evolution of our society and it results in an important indicator of how indispensable mobile phones have become in our daily life, a factor being in turn itself dependent on the increasing functions that can be performed through these devices. Considering that - as previously stated - this phenomenon has a strong impact on the increase in road accidents, on the economy and on public health, another solution might be to promote more restrictive regulations establishing a greater number of controls, using not only qualified personnel, but also innovative technologies possibly suitable for detecting real-time hands-on use of the mobile phone while driving.

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